



# STP16NK60Z - STB16NK60Z-S STW16NK60Z

N-CHANNEL 600V - 0.38Ω - 14A TO-220 / I<sup>2</sup>SPAK / TO-247

Zener-Protected SuperMESH™ MOSFET

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STP16NK60Z	600 V	< 0.42 Ω	14 A	190 W
STB16NK60Z-S	600 V	< 0.42 Ω	14 A	190 W
STW16NK60Z	600 V	< 0.42 Ω	14 A	190 W

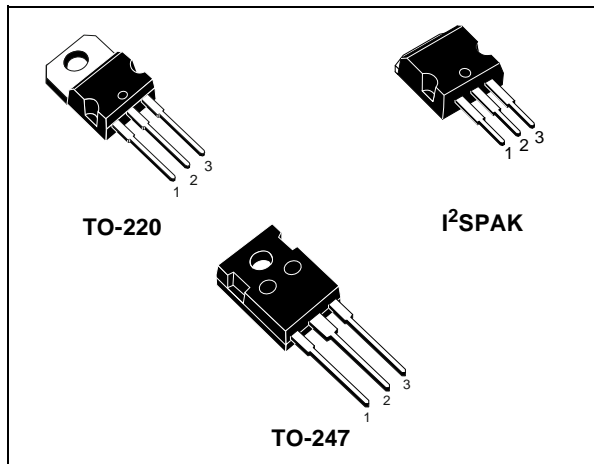
- TYPICAL R<sub>DS(on)</sub> = 0.38 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- 100% AVALANCHE TESTED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY

## DESCRIPTION

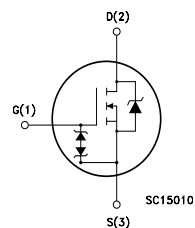
The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements ST full range of high voltage MOSFETs including revolutionary MDmesh™ products.

## APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES



## INTERNAL SCHEMATIC DIAGRAM



## ORDER CODE

PART NUMBER	MARKING	PACKAGE	PACKAGING
STP16NK60Z	P16NK60Z	TO-220	TUBE
STB16NK60Z-S	B16NK60Z	I <sup>2</sup> SPAK	TUBE
STW16NK60Z	W16NK60Z	TO-247	TUBE

## STP16NK60Z - STB16NK60Z-S - STW16NK60Z

### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source Voltage ( $V_{GS} = 0$ )	600	V
$V_{DGR}$	Drain-gate Voltage ( $R_{GS} = 20\text{ k}\Omega$ )	600	V
$V_{GS}$	Gate- source Voltage	$\pm 30$	V
$I_D$	Drain Current (continuous) at $T_C = 25^\circ\text{C}$	14	A
$I_D$	Drain Current (continuous) at $T_C = 100^\circ\text{C}$	8.8	A
$I_{DM}(\bullet)$	Drain Current (pulsed)	56	A
$P_{TOT}$	Total Dissipation at $T_C = 25^\circ\text{C}$	190	W
	Derating Factor	1.51	W/ $^\circ\text{C}$
$V_{ESD(G-S)}$	Gate source ESD (HBM-C= 100pF, R= 1.5K $\Omega$ )	6000	V
$dv/dt(1)$	Peak Diode Recovery voltage slope	4.5	V/ns
$T_j$ $T_{stg}$	Operating Junction Temperature Storage Temperature	-55 to 150	$^\circ\text{C}$

(●) Pulse width limited by safe operating area

(1)  $I_{SD} \leq 14\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

(\*) Limited only by maximum temperature allowed

### THERMAL DATA

		TO-220/ I <sup>2</sup> SPAK	TO-247	
R <sub>thj-case</sub>	Thermal Resistance Junction-case Max	0.66		$^\circ\text{C}/\text{W}$
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient Max	62.5	50	$^\circ\text{C}/\text{W}$
$T_l$	Maximum Lead Temperature For Soldering Purpose	300		$^\circ\text{C}$

### AVALANCHE CHARACTERISTICS

Symbol	Parameter	Max Value	Unit
$I_{AR}$	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max)	14	A
$E_{AS}$	Single Pulse Avalanche Energy (starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	360	mJ

### GATE-SOURCE ZENER DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-Source Breakdown Voltage	$I_{GS} = \pm 1\text{ mA}$ (Open Drain)	30			V

### PROTECTION FEATURES OF GATE-TO-SOURCE ZENER DIODES

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

## STP16NK60Z - STB16NK60Z-S - STW16NK60Z

### ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> = 25°C UNLESS OTHERWISE SPECIFIED) ON/OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source Breakdown Voltage	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0	600			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max Rating V <sub>DS</sub> = Max Rating, T <sub>C</sub> = 125 °C			1 50	μA μA
I <sub>GSS</sub>	Gate-body Leakage Current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ± 20V			±10	μA
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 100 μA	3	3.75	4.5	V
R <sub>DS(on)</sub>	Static Drain-source On Resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 7 A		0.38	0.42	Ω

### DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g <sub>fs</sub> (1)	Forward Transconductance	V <sub>DS</sub> = 15 V, I <sub>D</sub> = 7 A		12		S
C <sub>iss</sub> C <sub>oss</sub> C <sub>rss</sub>	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V <sub>DS</sub> = 25V, f = 1 MHz, V <sub>GS</sub> = 0		2650 285 62		pF pF pF
C <sub>oss</sub> eq. (3)	Equivalent Output Capacitance	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 480V		158		pF
t <sub>d(on)</sub> t <sub>r</sub> t <sub>d(off)</sub> t <sub>f</sub>	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 14 A R <sub>G</sub> = 4.7Ω V <sub>GS</sub> = 10 V (Resistive Load see, Figure 3)		30 25 70 15		ns ns ns ns
Q <sub>g</sub> Q <sub>gs</sub> Q <sub>gd</sub>	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V <sub>DD</sub> = 480V, I <sub>D</sub> = 14 A, V <sub>GS</sub> = 10V		86 17 46		nC nC nC

### SOURCE DRAIN DIODE

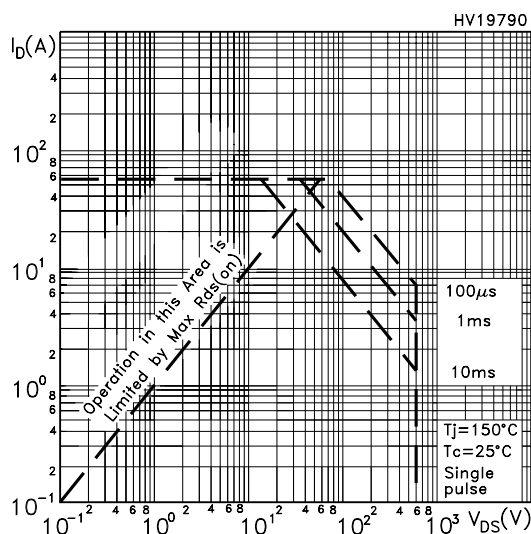
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I <sub>SD</sub> I <sub>SDM</sub> (2)	Source-drain Current Source-drain Current (pulsed)				14 56	A A
V <sub>SD</sub> (1)	Forward On Voltage	I <sub>SD</sub> = 14 A, V <sub>GS</sub> = 0			1.6	V
t <sub>rr</sub> Q <sub>rr</sub> I <sub>RRM</sub>	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I <sub>SD</sub> = 14 A, di/dt = 100 A/μs V <sub>DD</sub> = 100 V, T <sub>j</sub> = 25°C (see test circuit, Figure 5)		490 5.4 22		ns μC A
t <sub>rr</sub> Q <sub>rr</sub> I <sub>RRM</sub>	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I <sub>SD</sub> = 14 A, di/dt = 100 A/μs V <sub>DD</sub> = 100 V, T <sub>j</sub> = 150°C (see test circuit, Figure 5)		585 7 24		ns μC A

Note: 1. Pulsed: Pulse duration = 300 μs, duty cycle 1.5 %.

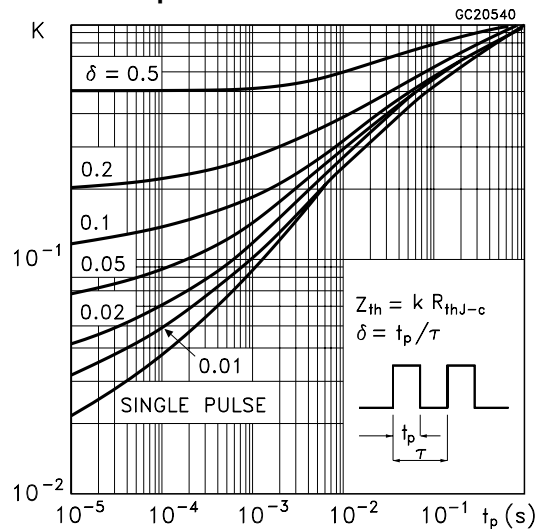
2. Pulse width limited by safe operating area.

3. C<sub>oss</sub> eq. is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>.

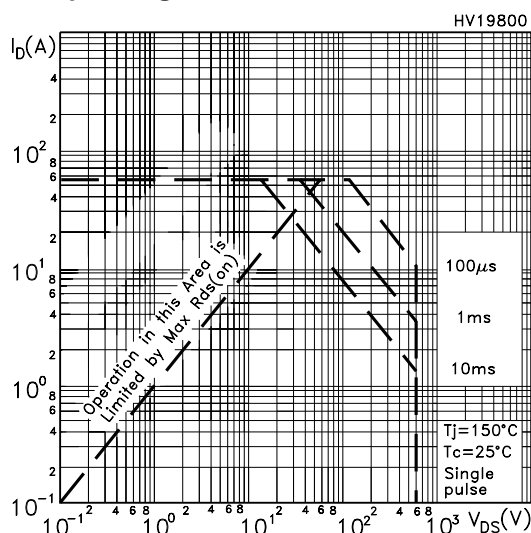
Safe Operating Area for TO-220/l<sup>2</sup>SPAK



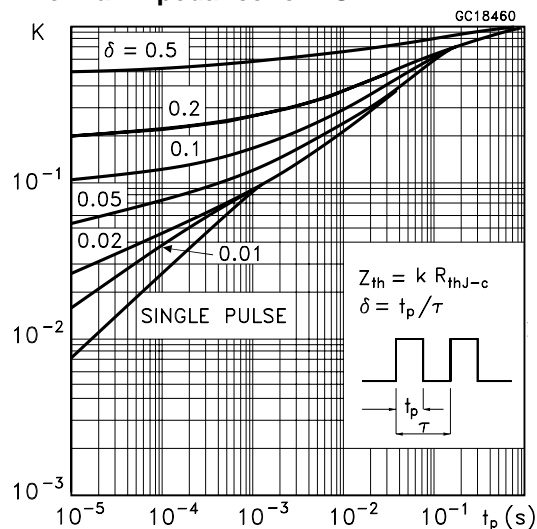
Thermal Impedance for TO-220/l<sup>2</sup>SPAK



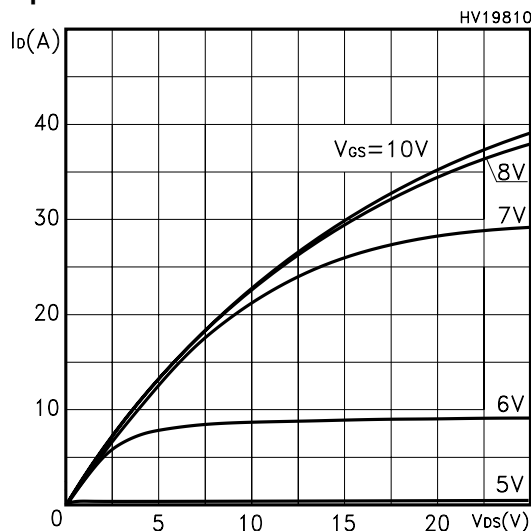
Safe Operating Area for TO-247



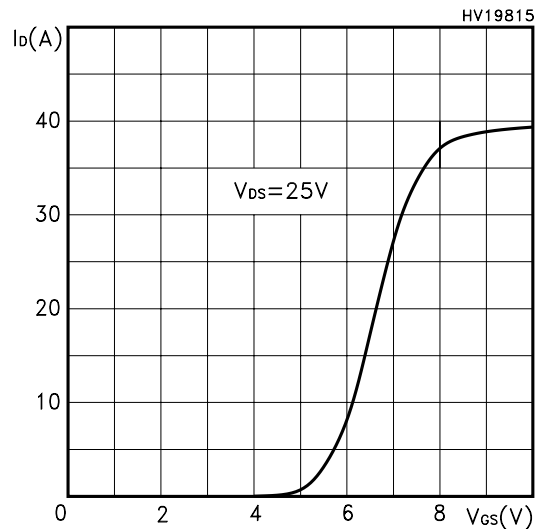
Thermal Impedance for TO-247



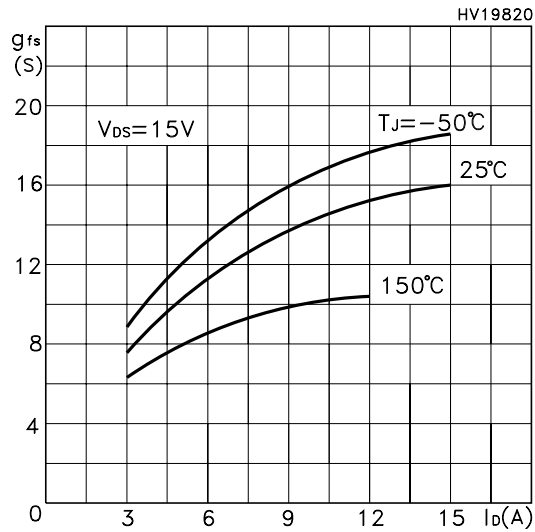
Output Characteristics



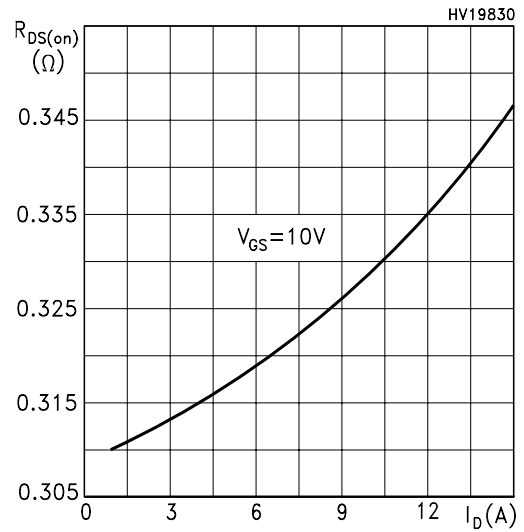
Transfer Characteristics



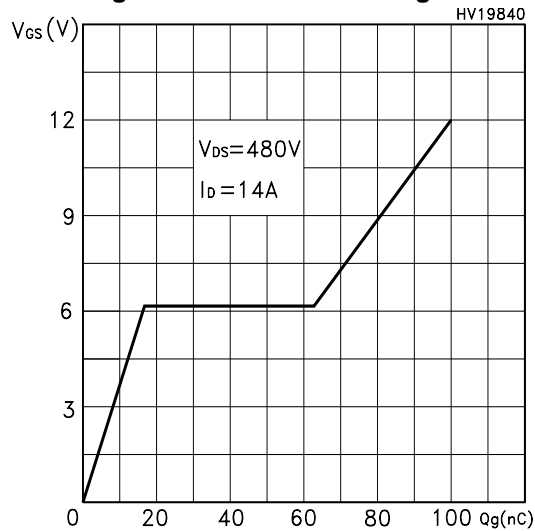
Transconductance



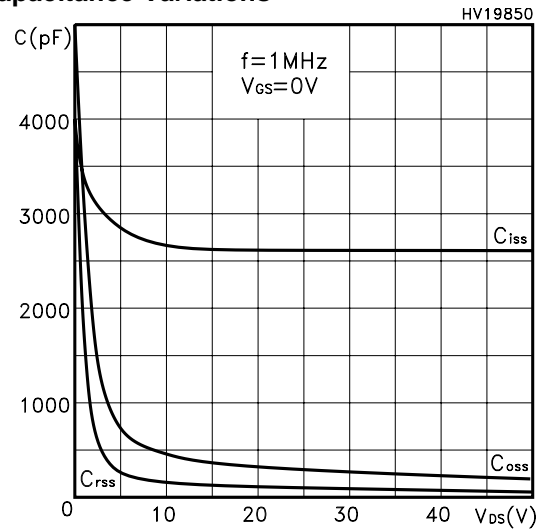
Static Drain-source On Resistance



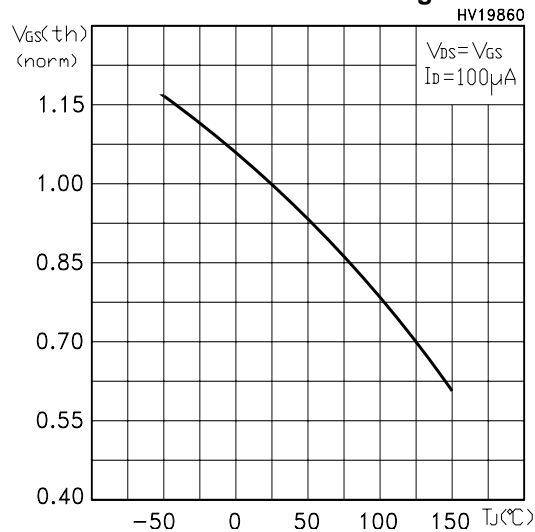
Gate Charge vs Gate-source Voltage



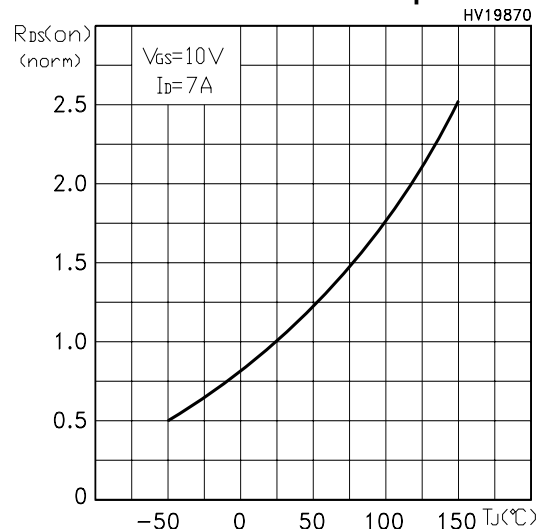
Capacitance Variations



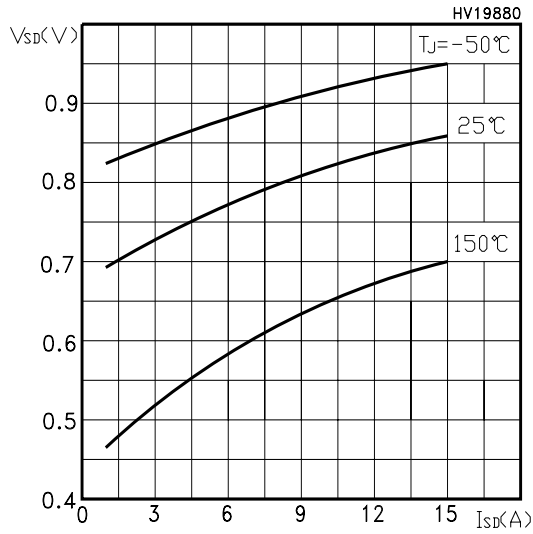
Normalized Gate Threshold Voltage vs Temp.



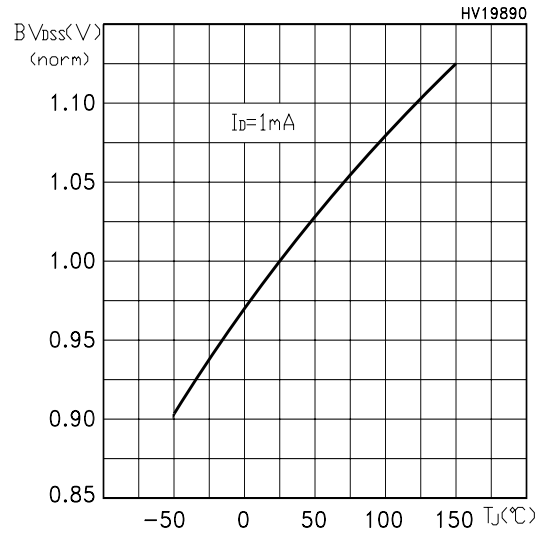
Normalized On Resistance vs Temperature



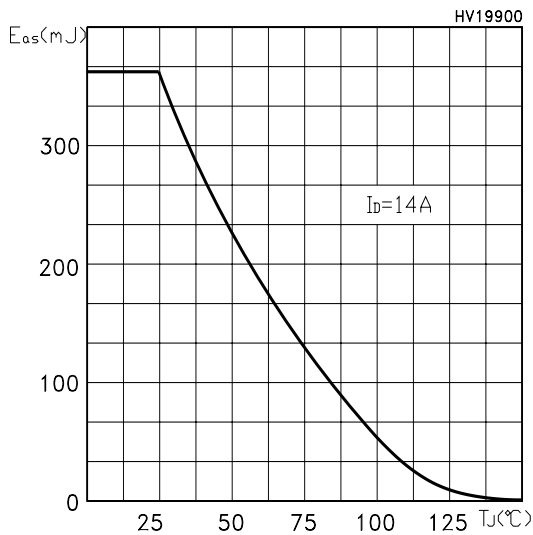
Source-drain Diode Forward Characteristics



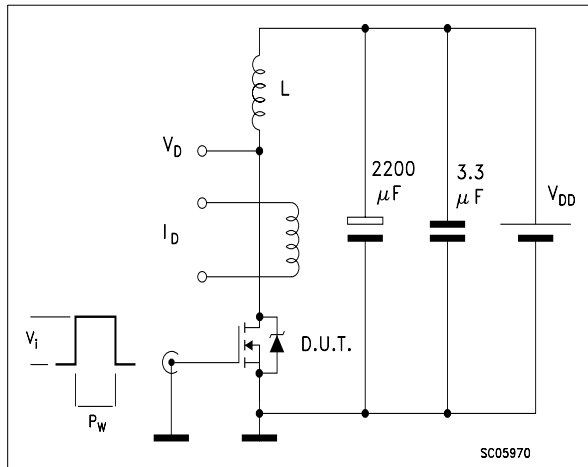
Normalized BVDSS vs Temperature



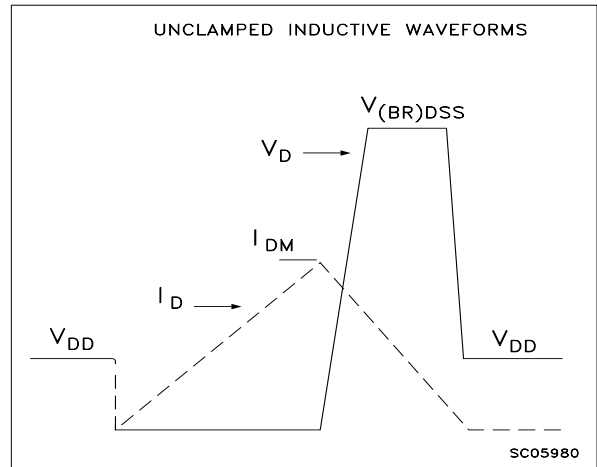
Maximum Avalanche Energy vs Temperature



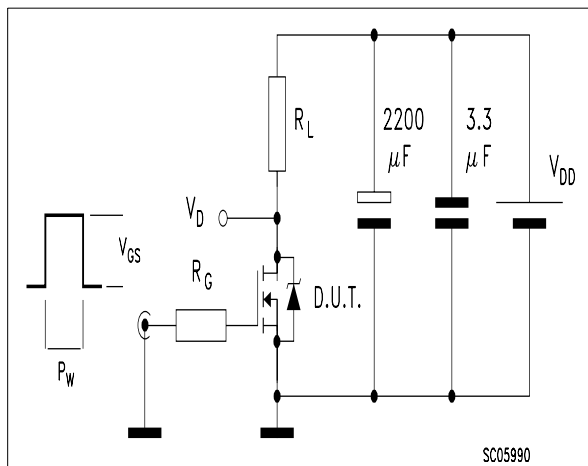
**Fig. 1: Unclamped Inductive Load Test Circuit**



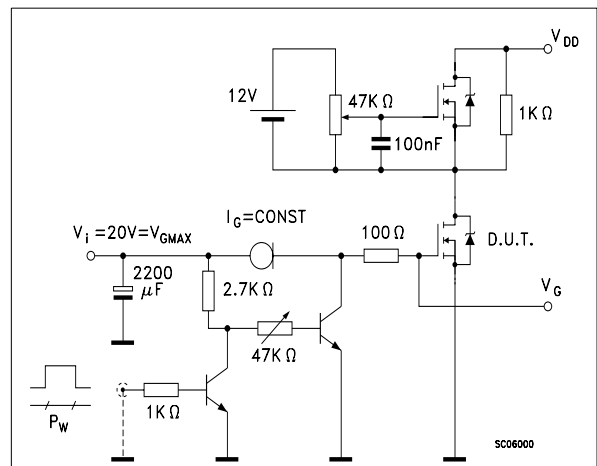
**Fig. 2: Unclamped Inductive Waveform**



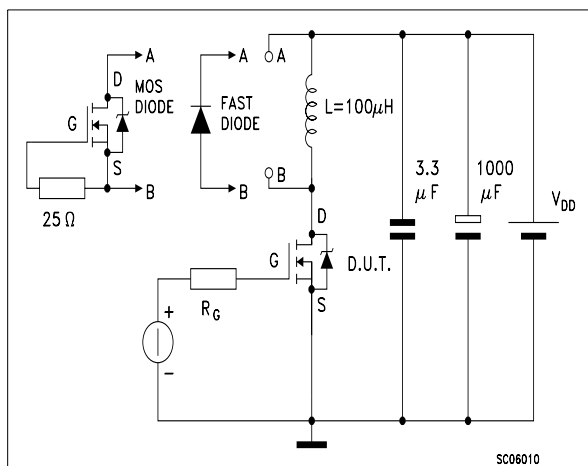
**Fig. 3: Switching Times Test Circuit For Resistive Load**



**Fig. 4: Gate Charge test Circuit**

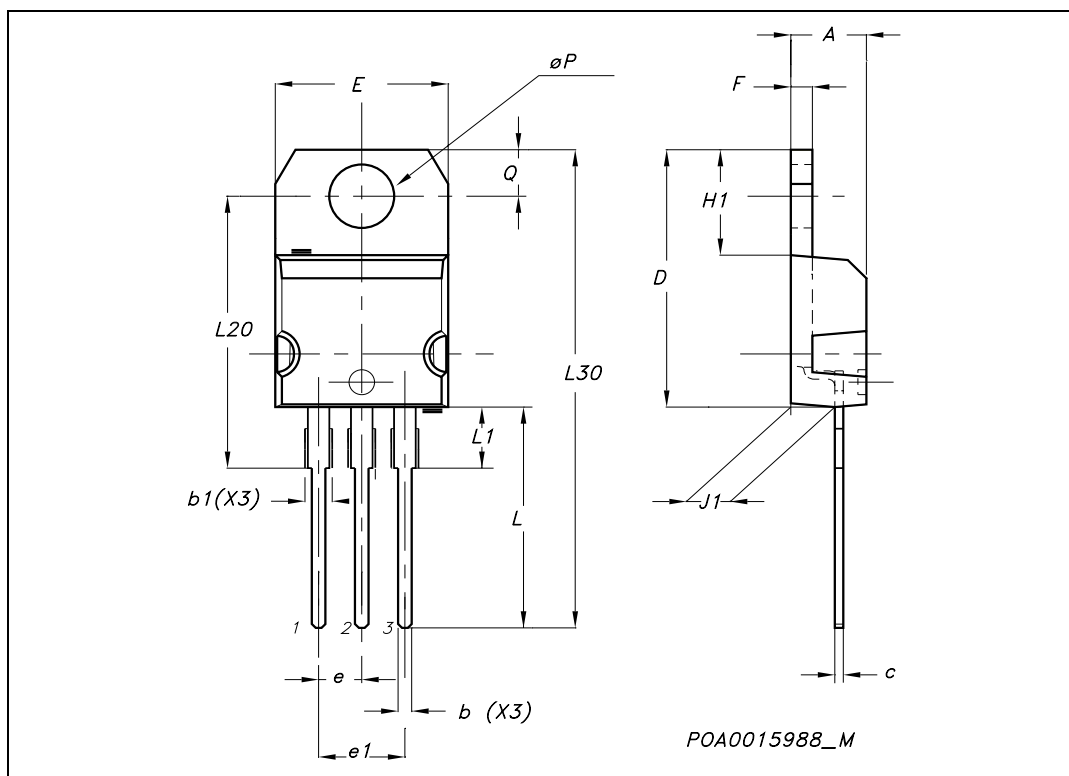


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



## TO-220 MECHANICAL DATA

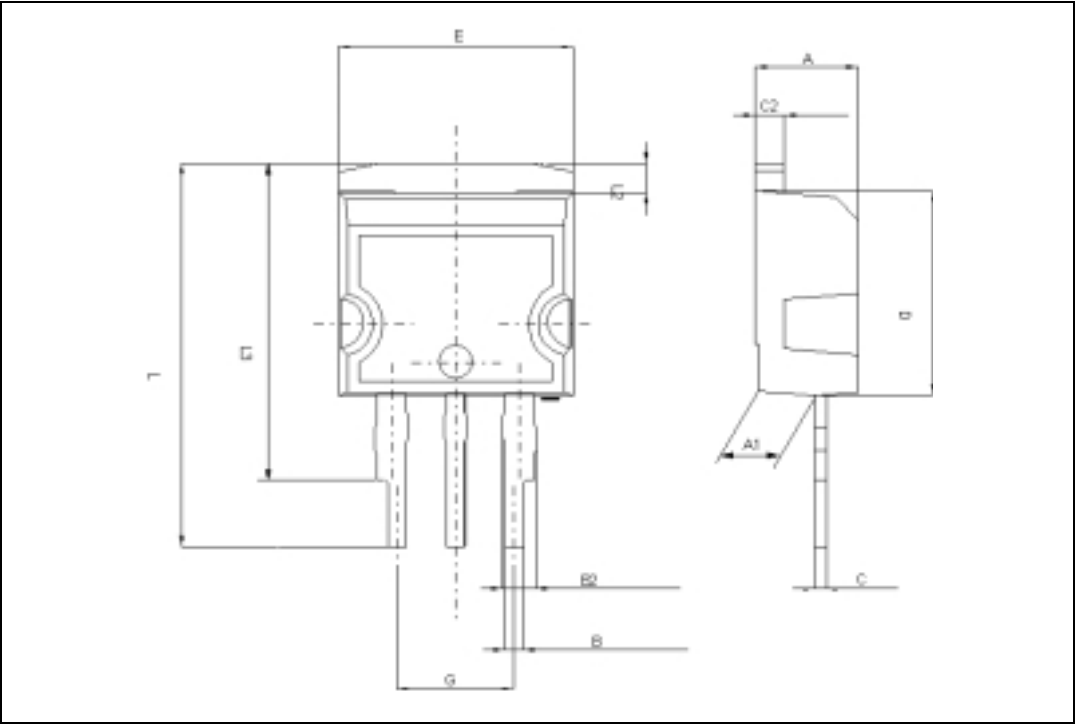
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.052
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116





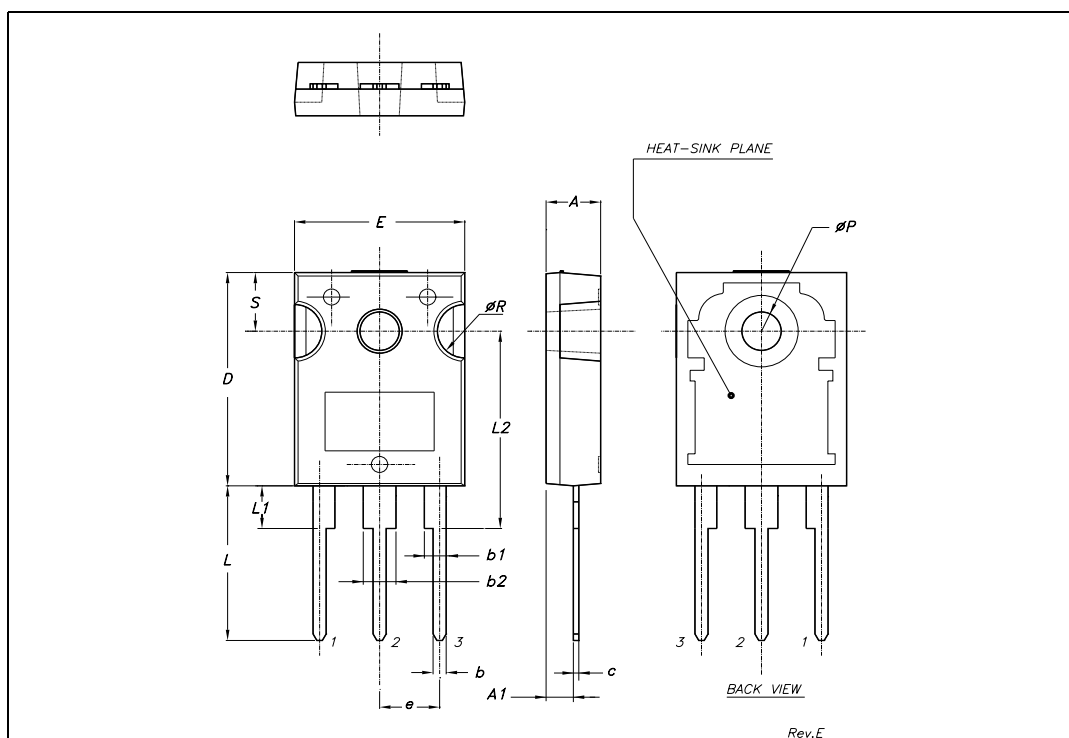
I<sup>2</sup>SPAK MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
A1	2.49		2.69	0.098		0.106
B	0.70		0.93	0.027		0.037
B2	1.14		1.70	0.045		0.067
C	0.45		0.60	0.018		0.024
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
E	10.00		10.40	0.394		0.409
G	4.88		5.28	0.192		0.208
L	16.7		17.5	0.657		0.689
L2	1.27		1.4	0.05		0.055
L3	13.82		14.42	0.544		0.568



## TO-247 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
A1	2.20		2.60	0.086		0.102
b	1.0		1.40	0.039		0.055
b1	2.0		2.40	0.079		0.094
b2	3.0		3.40	0.118		0.134
c	0.40		0.80	0.015		0.03
D	19.85		20.15	0.781		0.793
E	15.45		15.75	0.608		0.620
e		5.45			0.214	
L	14.20		14.80	0.560		0.582
L1	3.70		4.30	0.14		0.17
L2		18.50			0.728	
øP	3.55		3.65	0.140		0.143
øR	4.50		5.50	0.177		0.216
S		5.50			0.216	



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